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$\bar{p}$ NOTE #400

ANTIPROTON TARGET VAULT BY PASS LINE BEAM STOP

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Introduction

After tune up of the Accumulator/Debuncher rings with protons from the Booster target station the protons will be dumped on a beam stop located in the bypass line around the Anti-proton target station. This will allow for tune up and studies of nearly the whole antiproton accumulation and injection complex. This note will review the radiation aspects of this beam stop location.

Calculations

Figures 1 and 2 show the location and shielding configuration of the beam stop in the antiproton target vault. The size of the steel beam stop used in the model is three inches square by five feet long. The area above the shielding over the stop is enclosed within a concrete barrier nine feet tall and three feet thick that is interlocked during operation, however it is open topped and the dose rates should be kept low to limit scattering and "skyshine" into adjacent spaces. Dose rates within the barrier for dumping 8 GeV protons were calculated from MAXIM runs with extra regions for tabulating star densities in the areas of concern (Fig. 3). From MAXIM run JSN = AAQE the worst location was $7.0 \times 10^{10} \frac{\text{stars}}{\text{cm}^3 \cdot \text{p}}$ (region 4) and at $\frac{10^{10} \text{p}}{2 \text{ sec}}$ results in a dose rate of:

$$\left(7\times10^{10}\frac{\text{stars}}{\text{cm}^3\cdot\text{p}}\right)\left(\frac{10^{10}\text{p}}{2\cdot\text{sec}}\right)\left(\frac{3600\ \text{sec}}{\text{hr}}\right)\left(\frac{.01\ \text{mrem}}{\text{star/cm}^3}\right) = 126\ \frac{\text{mrem}}{\text{hr}}$$

This is satisfactory for an exclusion area that is interlocked however the caveat of TM1136[1] (skyshine may require some modifications "after the fact") still applies for adjacent spaces.

The soil activation was calculated in the ususal manner of TM816[2]. The elevations, distances to aquifers, decay factors, etc, are the same as in $\bar{p}$ Note 295[3]. The geometry modeled is depicted in Figure 3. The stars per proton in unprotected soil to the side is .0439 $\frac{\text{stars}}{\text{p}}$ and in unprotected soil below is .0349 $\frac{\text{stars}}{\text{p}}$ as calculated by MAXIM run JSN=AARB. Then for 100% of the limit at this location (no anti proton targeting):

$$H_3\ \frac{\rho\text{Ci}}{\text{m}\ell} = \frac{\chi\ \text{p/yr}\ (3.7\times10^{-9}\rho\frac{\text{Ci}}{\text{star}})}{5.55\ \text{x}\ 10^7\ \text{m}\ell/\text{yr}}\left[(.725)(.439)+(.697)(.0349)\right]\frac{\text{stars}}{\text{p}} =$$

$$\chi\cdot3.7\times10^{-18}\frac{\rho\text{Ci}}{\text{m}\ell}$$

$$Na_{22}\frac{\rho\text{Ci}}{\text{m}\ell} = \frac{\chi\text{p/yr}\ (9.0\times10^{-10}\rho\frac{\text{Ci}}{\text{star}})}{5.55\times10^7\ \text{m}\ell/\text{yr}}\left[(.0328)(.0439)+(.0216)(.0349)\right]\frac{\text{stars}}{\text{p}} =$$

$$\chi\cdot3.56\times10^{-20}\frac{\rho\text{Ci}}{\text{m}\ell}$$

with $20\frac{\rho\text{Ci}}{\text{m}\ell}$ limit for H_3 and $.2\frac{\rho\text{Ci}}{\text{m}\ell}$ limit for Na_{22}

$$1 \geq \Sigma\left(\frac{H_3}{20} + \frac{Na_{22}}{.2}\right) = \chi\left(\frac{3.7\times10^{-18}}{20} + \frac{3.56\times10^{-20}}{.2}\right)$$

$$= \chi\left(3.63\times10^{-19}\right)$$

$$\chi \leq 2.7 \times 10^{18} \text{ p/yr}$$

If the unlikely situation of the under drains failing occurs the protected soil to the side with .262 $\frac{\text{stars}}{\text{p}}$ would be included and the location is still good for 5.9×10^{17} p/yr.

Conclusion

The shielding depicted in Figures 1 and 2 is sufficient for dumping of 8 GeV protons at $10^{10} \frac{\text{p}}{2 \text{ sec}}$ and maintaining reasonable radiation levels in the exclusion area above, however as in the case of the anti proton target operation, surveys will be required to determine the extent of scattering or skyshine outside this area. The soil activation is less of a concern and even at 10% of the limit for this location affords over 20 million pulses per year at 10^{10} p/pulse.

Reference

1) J.D. Cossairt and P. Yurista, "Shielding Calculations for the Antiproton Target Area", TM-1136, September, 1982.

2) P.J. Gollon, "Soil Activation Calculations for the Antiproton Target Area", TM-816, September, 1978.

3) P. Yurista, "Soil Activation Antiproton Target Station" $\bar{p}$ Note-295.

Figures

1) a) Vertical plane through beam stop along axis.

   b) Vertical plane through beam stop perpendicular to axis.

2) a) Vertical plane perpendicular to beam line (Z=650)

   b) Vertical plane perpendicular to beam line (Z=800)

3) a) MAXIM model in vertical plane through beam stop along axis.

   b) MAXIM model in vertical plane through beam stop perpendicular to axis.

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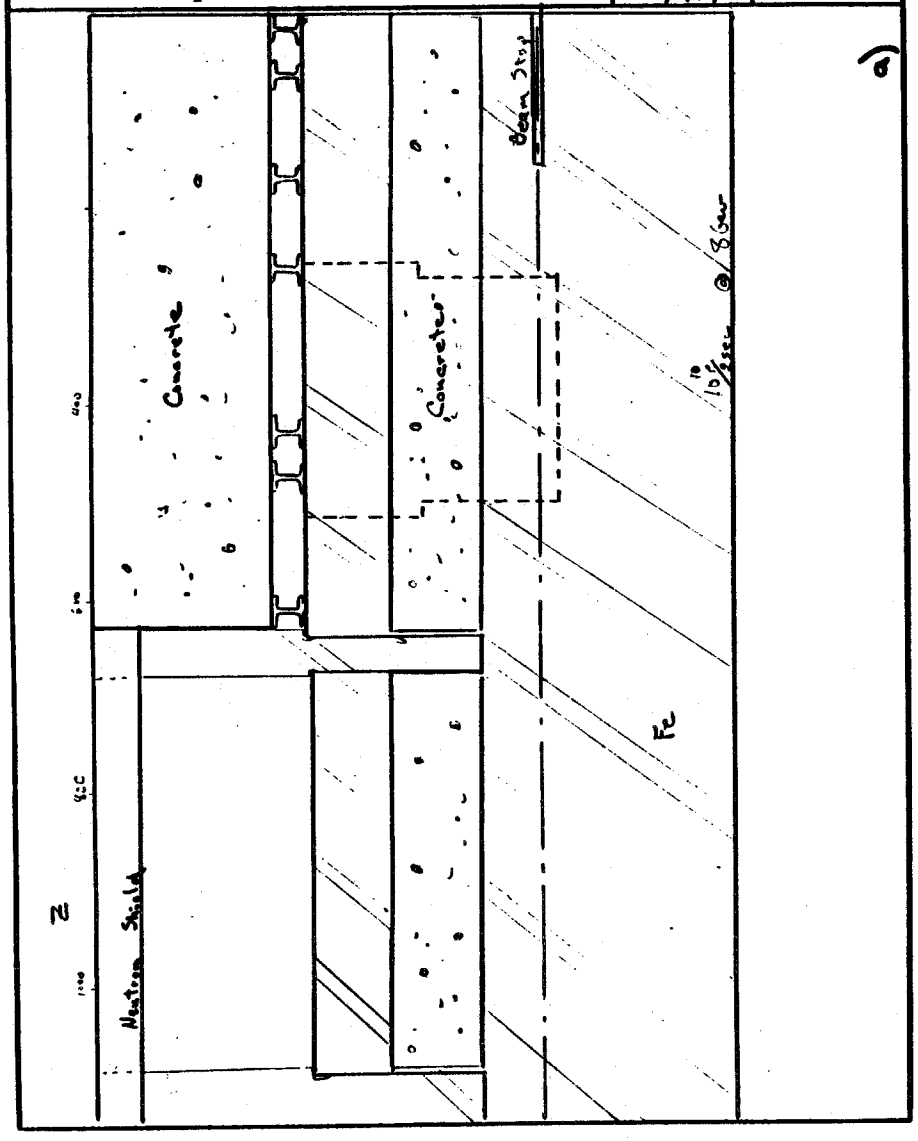

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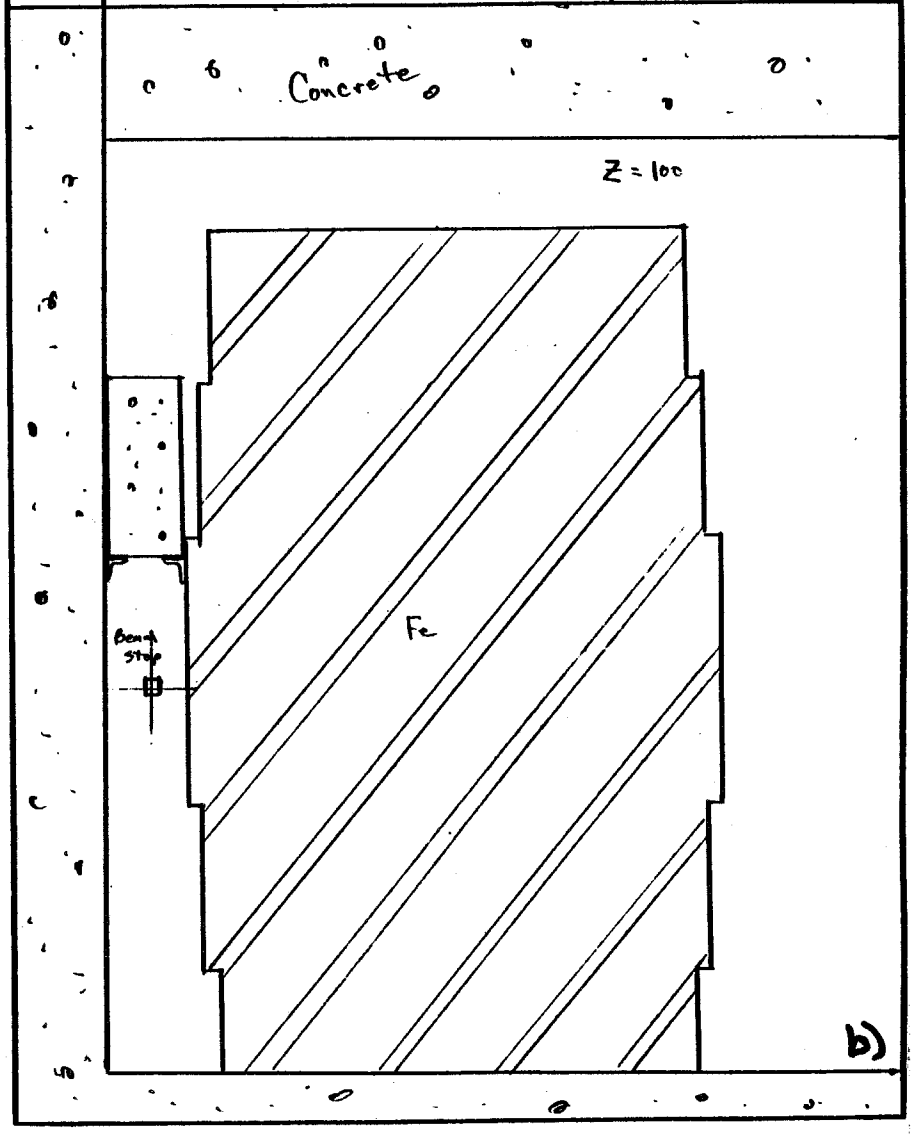

Fig 1

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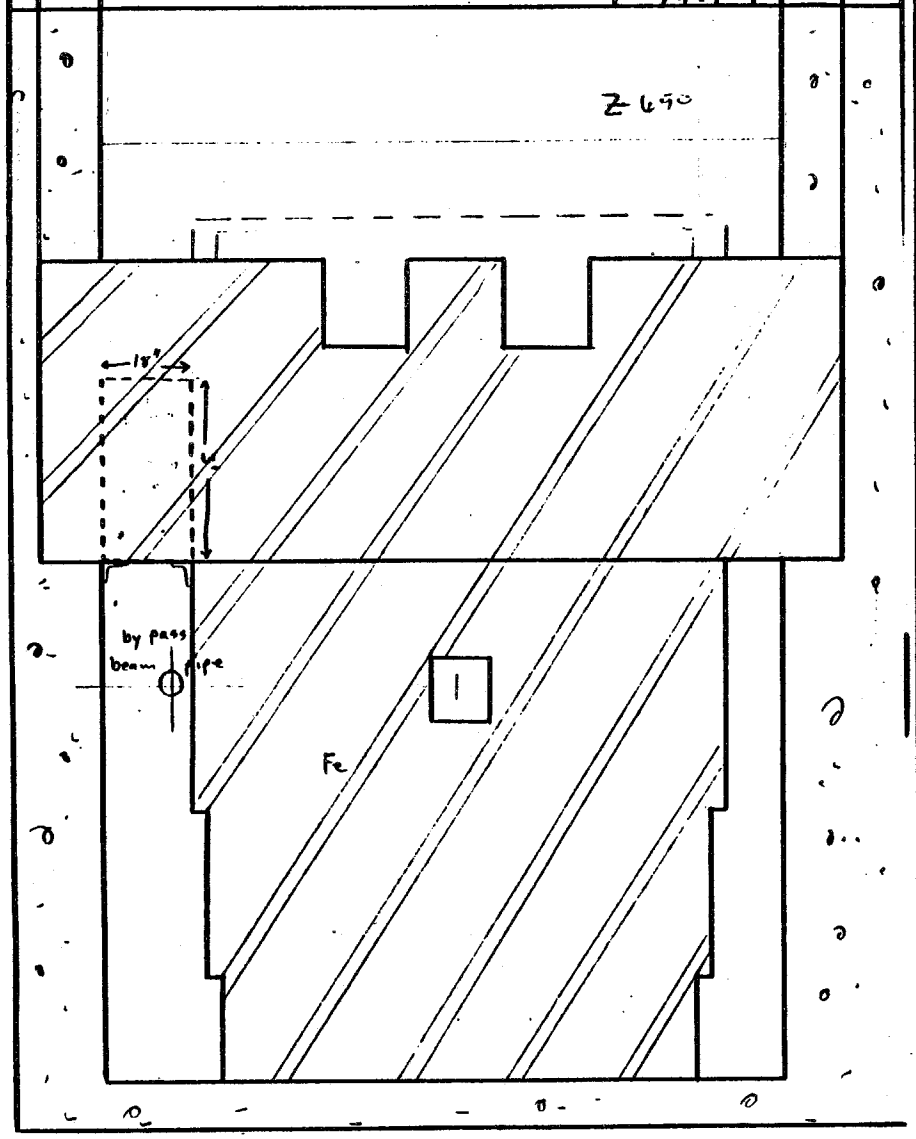

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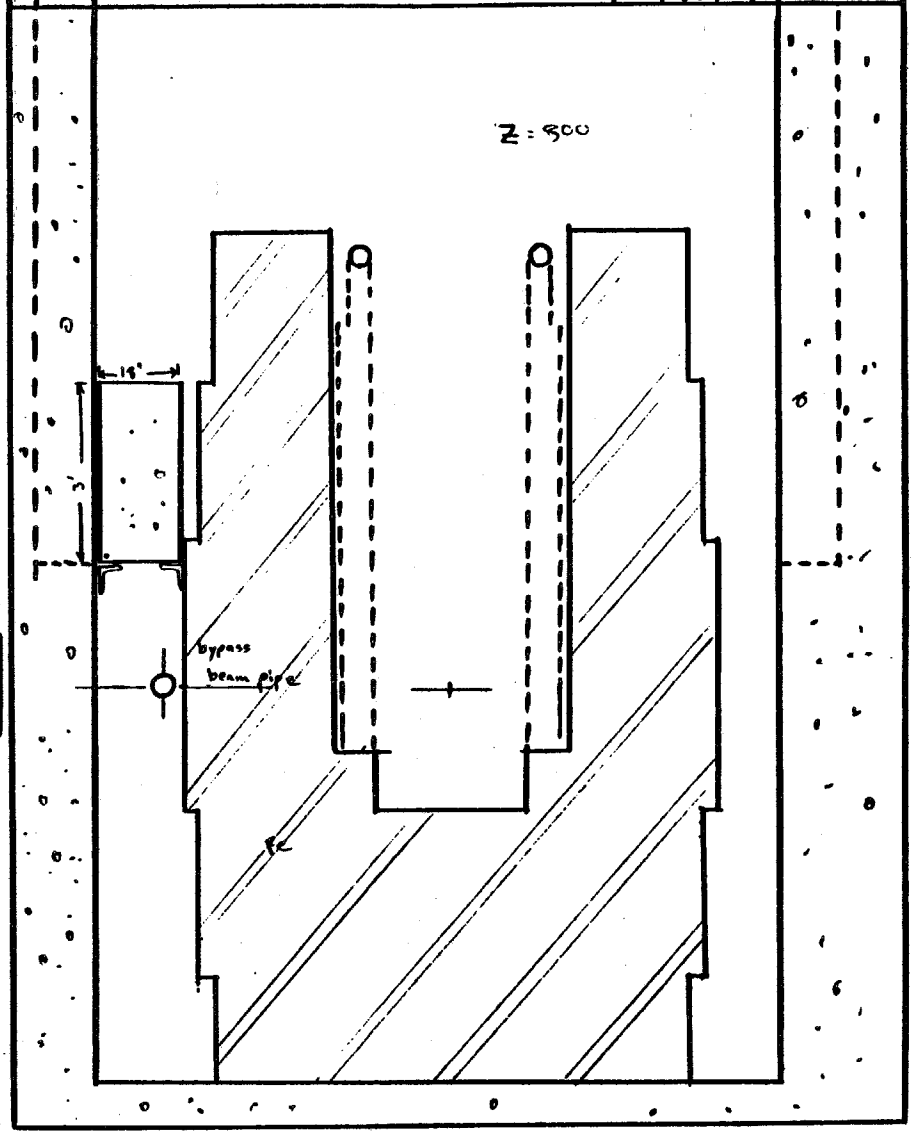

FIG 2

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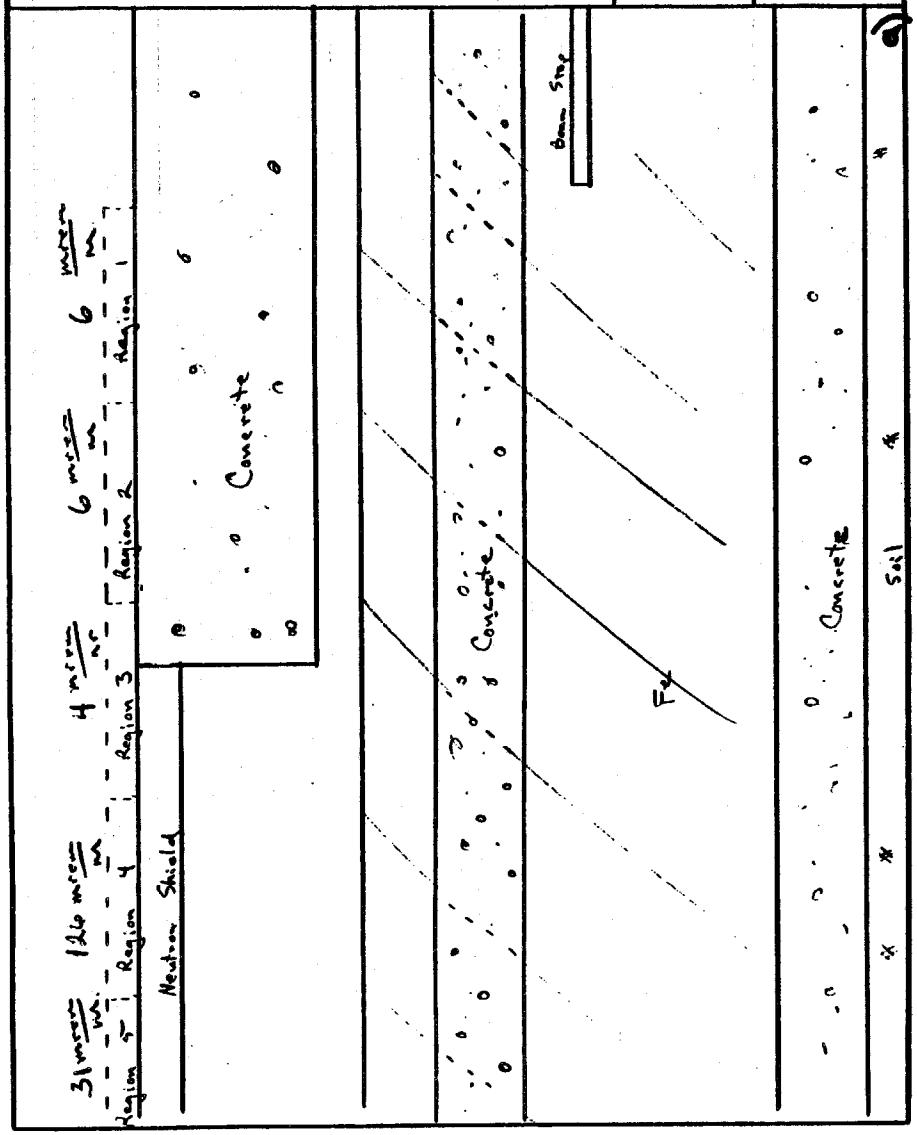

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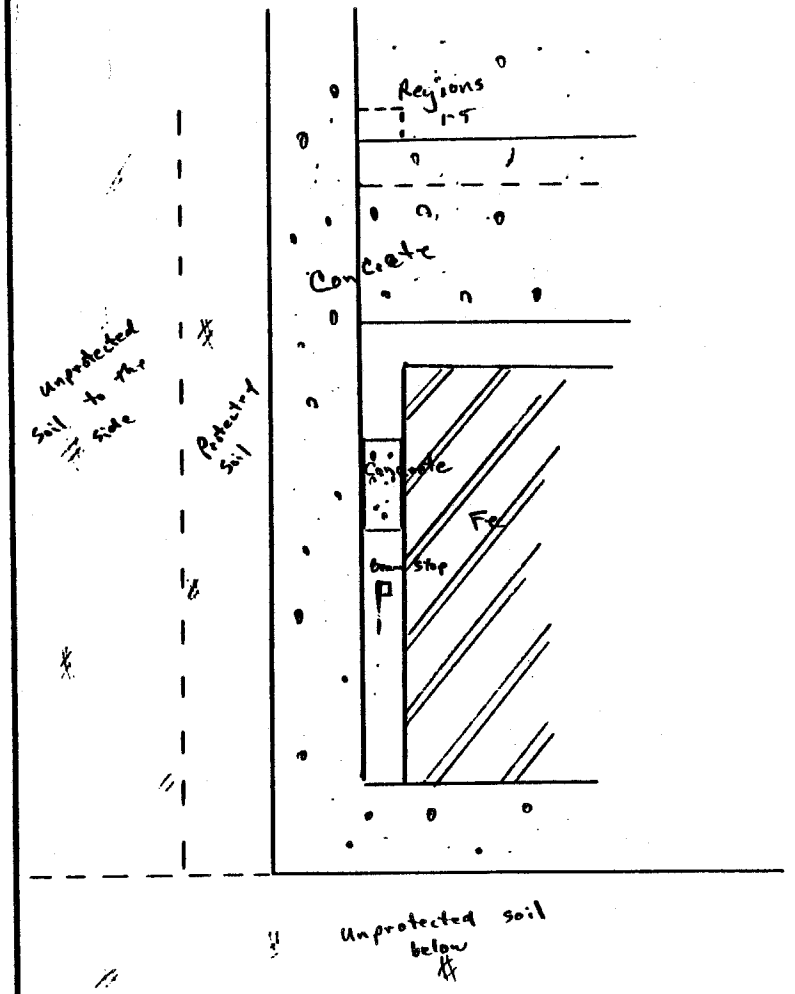

b)

FIG 3